Laser Pantography

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Laser Pantography (LP) is a unique lithographic technology created at LLNL in support of a number of projects and programs. LP is the only technology that can routinely draw patterns on 3-D objects such as cylinders, spheres, flats, and diamonds. These patterns are usually metal, and are typically used as circuits for sensors and actuators.

In one example, LP is being used to pattern coils on the tips of microcatheters intended for use in the brains of stroke patients (Fig. 1). These coils can be energized with a continuous current, creating a magnetic moment that will attempt to align with an exterior field, such as the magnetic field of an MRI. This magnetic interaction will cause the catheter to deflect, in effect steering it. By having three orthogonal coils on the catheter, the tip can be deflected in any direction, providing a mechanism for guiding the catheter into a desired blood vessel. Other uses of LP include the fabrication of microreceiver coils for a portable NMR spectrometer (Fig. 2), and the patterning of tungsten sensors on the tips of diamond anvils for the study of material properties at high pressure (Fig. 3).

For over two decades the various LP systems have been physically separate from most of the micro- and nanofabrication facilities and personnel. This project endeavors to collocate the systems with other capabilities and integrate with existing programs and projects in the micro- and nanotechnology area.

Project Goals

The purpose of this project is to ensure the future vitality of this unique capability. Specific goals include:

1. moving the two LP systems and all associated support hardware to the micro- and nanofabrication center at LLNL in order to better integrate with and leverage other capabilities;
2. training new technical staff in the technique; and

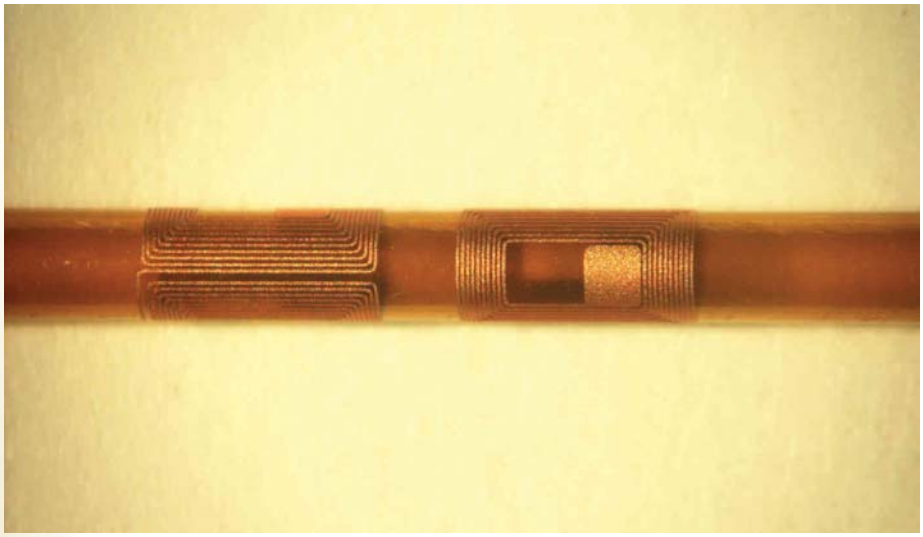

Figure 1. Orthogonal saddle coils on polyimide cylinders for MRI guided catheters.

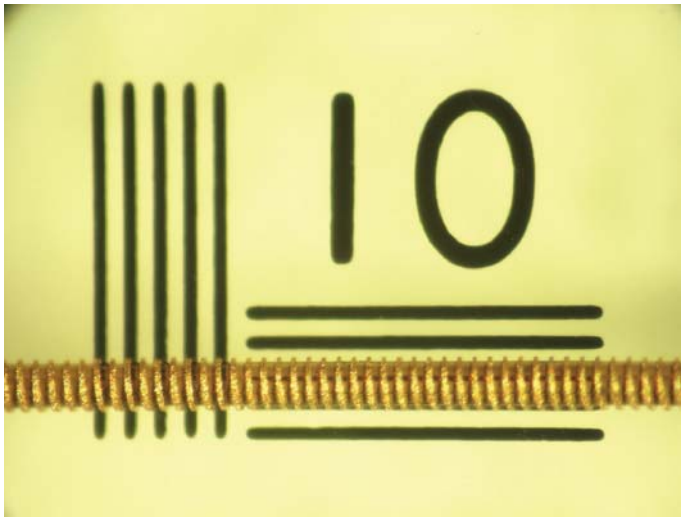

Figure 2. 150-mm OD helical coil for a portable NMR spectrometer.

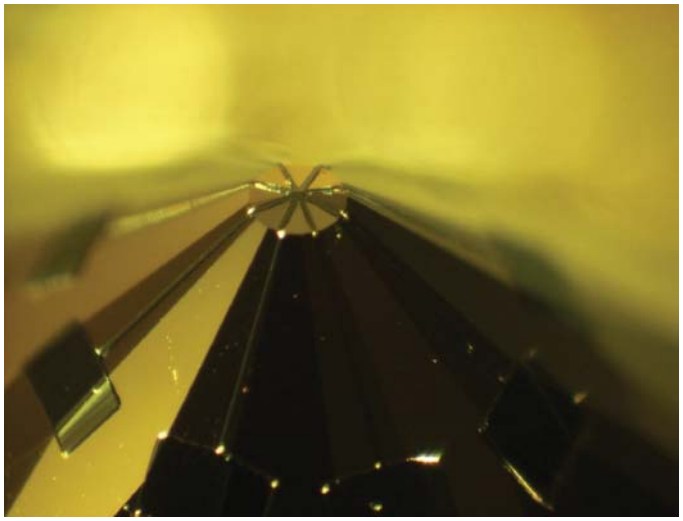

Figure 3. Designer diamond anvil with LP-generated electrodes and contact pads.

3. educating the LLNL micro- and nanofabrication community so that LP can be integrated with existing and future projects and programmatic work.

Relevance to LLNL Mission

The ability to fabricate microscale patterns on arbitrary 3-D surfaces (slopes, spheres, cylinders, and compound curvatures) is a unique capability available only via the LLNL LP process. These systems and processes have serviced critical program needs in the past and the vitality of the technique needs to be maintained in order to do so in the future. The availability and advancement of LP will contribute to the core microfabrication competencies at LLNL that provide vital support to both internal and external customers.

FY2007 Accomplishments and Results

Two LP systems have been moved to the LLNL microfabrication facility. These systems include a full five-axis tool with a diode laser and three-axis system with an Ar-ion laser. Also included were laser system enclosures, floating optical tables, and associated computer controls and electronics. Figure 4 shows the five-axis LP system in its enclosure with computer controls at its new location.

In addition to the lasers and associated equipment, an entire set of other support equipment, including a wet processing bench and sputter tool, was moved.

Training of new personnel and education of the micro- and nanofabrication community at LLNL has been ongoing throughout this project. New engineers and technicians have been involved with patterning 3-D components for the projects that LP currently supports: portable NMR, MRI guided catheters, and diamond anvils. These personnel have also participated in planning and strategy meetings with customers to better understand individual project needs. LP experts have actively marketed the technology to potential new customers and other microfabrication personnel via a series of seminars and individual meetings and tours to give the community at large a better understanding of the capability.

As a result of this work, the LP capabilities have been both physically and intellectually integrated with the micro- and nanofabrication community at LLNL. This is critical to maintaining and advancing this important and unique technology that is capable of patterning features on any 3-D surface.

Figure 4. An LP system in its new location.